

Claims

WHAT IS CLAIMED IS:

1. Apparatus for determining an absolute angular velocity of a vehicle that rotates during operation about an axis of rotation, said apparatus comprising:

a motor having a stator mountable on the vehicle for movement with the vehicle and a rotor rotatably mounted on the stator for rotation about a rotor axis generally aligned with the axis of rotation of the vehicle;

a gyroscope coupled to the motor rotor for rotation with respect to the stator about the rotor axis, the gyroscope having an input axis generally aligned with the rotor axis, the gyroscope being configured to produce a gyroscope output signal representing an absolute angular velocity at which the gyroscope travels about the input axis;

a motor control operatively connected to the motor for controlling a speed of rotation of the rotor, said control being configured to rotate the gyroscope about the input axis in a direction opposite to the angular velocity of the vehicle so the gyroscope output signal tends to remain about zero; and

a resolver having a stationary member mountable on the vehicle for movement with the vehicle and a rotating member coupled to the motor rotor for rotation with the motor rotor about the rotor axis, the resolver being configured to produce a resolver output signal representing a rotational speed of the rotating member about the rotor axis that corresponds to the speed of rotation of the motor rotor and likewise corresponds to the absolute angular velocity of the vehicle about the axis of rotation.

2. Apparatus in accordance with Claim 1 further comprising a mount mountable on the vehicle for movement with the vehicle, the motor stator being coupled to the mount for movement with the mount.

3. Apparatus in accordance with Claim 2 wherein the mount comprises a generally cylindrical housing and a flange extending radially outward from an outer surface of the housing for mounting the housing to the vehicle.

4. Apparatus in accordance with Claim 1 further comprising a shaft rotatably mounted on the vehicle for rotation with respect to the vehicle about the rotor axis, the shaft being coupled to the motor rotor for rotation with the motor rotor about the rotor axis, the gyroscope being coupled to the shaft for rotation with the shaft about the rotor axis, the resolver rotating member being coupled to the shaft for rotation with the shaft about the rotor axis.

5. Apparatus in accordance with Claim 4 further comprising a plurality of slip rings mounted on the shaft, the plurality of slip rings being operatively connected to the gyroscope and the motor control.

6. Apparatus in accordance with Claim 4 further comprising a plurality of bearings mounted between the vehicle and the shaft for facilitating rotation of the shaft with respect to the vehicle.

7. Apparatus in accordance with Claim 1 wherein the resolver includes a processor for producing the resolver output signal.

8. An apparatus in accordance with Claim 1 wherein the gyroscope is selected from a group of gyroscopes consisting of a ring laser gyroscope, an interferometric fiber optic gyroscope, and a hemispherical resonating gyroscope.

9. A vehicle that rotates during operation about an axis of rotation, the vehicle comprising:

a body;

a control system mounted on the body for controlling motion of the vehicle during operation of the vehicle; and

apparatus operatively connected to the control system for determining an absolute angular velocity of the vehicle during operation of the vehicle, the apparatus comprising:

a motor having a stator mounted on the vehicle for movement with the vehicle and a rotor rotatably mounted on the stator for rotation about a rotor axis generally aligned with the axis of rotation of the vehicle;

a gyroscope coupled to the motor rotor for rotation with respect to the stator about the rotor axis, the gyroscope having an input axis generally aligned with the rotor axis, the gyroscope being configured to produce a gyroscope output signal representing an absolute angular velocity at which the gyroscope travels about the input axis;

a motor control operatively connected to the motor for controlling a speed of rotation of the rotor, said motor control being configured to rotate the gyroscope about the input axis in a direction opposite to the angular velocity of the vehicle so the gyroscope output signal tends to remain about zero; and

a resolver having a stationary member mounted on the vehicle for movement with the vehicle and a rotating member coupled to the motor rotor for rotation with the motor rotor about the rotor axis, the resolver being configured to transmit to the control system a resolver output signal representing a rotational speed of the rotating member about the rotor axis that corresponds to the speed of rotation of the motor rotor and likewise corresponds to the absolute angular velocity of the vehicle about the axis of rotation, the control system being configured to use the resolver output signal to control the absolute angular velocity of the vehicle to thereby spin-stabilize the vehicle.

10. A vehicle in accordance with Claim 9 further comprising a mount mounted on the vehicle body for movement with the vehicle, the motor stator being coupled to the mount for movement with the mount.

11. A vehicle in accordance with Claim 10 wherein the mount comprises a generally cylindrical housing for the apparatus and a flange extending radially outward from an outer surface of the housing, the flange being mounted to the vehicle body.

12. A vehicle in accordance with Claim 11 wherein the housing includes an interface mounted on the outer surface of the housing for operatively connecting the apparatus to the control system.

13. A vehicle in accordance with Claim 10 further comprising a shaft rotatably mounted on the mount for rotation with respect to the mount about the rotor axis, the shaft being coupled to the motor rotor for rotation with the motor rotor about the rotor axis, the gyroscope being coupled to the shaft for rotation with the shaft about the rotor axis, the resolver rotating member being coupled to the shaft for rotation with the shaft about the rotor axis.

14. A vehicle in accordance with Claim 13 further comprising a plurality of slip rings mounted on the shaft, the plurality of slip rings being operatively connected to the gyroscope and to the motor control.

15. A vehicle in accordance with Claim 13 further comprising a plurality of bearings mounted between the mount and the shaft for facilitating rotation of the shaft with respect to the mount.

16. A vehicle in accordance with Claim 9 wherein the resolver includes a processor for producing the resolver output signal.

17. A vehicle in accordance with Claim 9 wherein the gyroscope is selected from a group of gyroscopes consisting of a ring laser gyroscope, an interferometric fiber optic gyroscope, and a hemispherical resonating gyroscope.

18. A vehicle in accordance with Claim 9 wherein the vehicle comprises a missile.

19. A vehicle in accordance with Claim 9 wherein the vehicle comprises a satellite.

20. A method for determining an absolute angular velocity of a vehicle that rotates during operation about an axis of rotation, the vehicle including a vehicle body and a gyroscope rotatably mounted on the body for rotation with respect to the body about a gyroscope axis generally aligned with the axis of rotation, said method comprising the steps of:

rotating the gyroscope with respect to the vehicle body about the gyroscope axis in a direction opposite to rotation of the vehicle so an absolute angular velocity of the gyroscope about the gyroscope axis tends to remain about zero; and

measuring a rotational speed of the gyroscope about the gyroscope axis with respect to the vehicle body, said rotational speed corresponding to the absolute angular velocity of the vehicle about the axis of rotation.